

WHAT IS CLAIMED IS:

1. A coupling assembly comprising:
a component having a surface, the surface defining a port opening for a port
which extends into the component,
5 wherein the port has first, second, and third diameters, which are at respective
positions from closer to the port opening to further inside the port, the first diameter
being larger than the second diameter and the third diameter being smaller than the
second diameter, and
wherein the port widens at an angle α between the third diameter and the
10 second diameter, and the port widens at an angle β between the second diameter and
the first diameter, the angle α being different than the angle β ;
a conduit having an annular bead, wherein an end of the conduit can be slidably
inserted into the port such that the end of the conduit extends beyond the position of the
third diameter and at least a portion of the annular bead extends beyond the port
15 opening; and
a seal extending around the conduit between the annular bead and the position
of the third diameter.
2. A coupling assembly as claimed in claim 1, wherein the angle α is larger
than the angle β .
3. A coupling assembly as claimed in claim 2, wherein the angle α is in a
range from 28 degrees to 32 degrees.
4. A coupling assembly as claimed in claim 2, wherein the angle β is in a
range from 8.5 degrees to 15.5 degrees.
5. A coupling assembly as claimed in claim 4, wherein the angle β is in a
range from 11.5 degrees to 12.5 degrees.

6. A coupling assembly as claimed in claim 1, wherein the port has a fourth diameter at a position between the first diameter and the port opening, wherein the fourth diameter is larger than the first diameter.

7. A coupling assembly as claimed in claim 6, wherein the port has an annular surface defining a portion of the port having the fourth diameter.

8. A coupling assembly as claimed in claim 7, wherein the angle β is in a range from 8.5 degrees to 15.5 degrees.

9. A coupling assembly as claimed in claim 8, wherein the angle β is in a range from 11.5 degrees to 12.5 degrees.

10. A coupling assembly as claimed in claim 1, further comprising a secondary port opening for a secondary port which extends into the component, wherein the secondary port has first, second, and third secondary-port diameters, which are at respective positions from closer to the secondary port opening to further inside the secondary port, the first secondary-port diameter being larger than the second secondary-port diameter and the third secondary-port diameter being smaller than the second secondary-port diameter,

wherein the secondary port widens at said angle α between the third secondary-port diameter and the second secondary-port diameter, and the secondary port widens at said angle β between the second secondary-port diameter and the first secondary-port diameter.

11. A coupling assembly as claimed in claim 10, wherein at least a portion of said port and said secondary port extend somewhat in parallel into the component from said face.

12. A coupling assembly as claimed in claim 10, wherein the secondary port has a fourth secondary-port diameter at a position between the first secondary-port diameter and the secondary port opening, wherein the fourth secondary-port diameter is

larger than the first secondary-port diameter, and

- 5 wherein the secondary port has an annular surface defining a portion of the secondary port having the fourth secondary-port diameter.

13. A coupling assembly as claimed in claim 12, wherein the first, second, third, and fourth diameters of the port are larger than the first, second, third, and fourth secondary-port diameters of the secondary port, respectively.

14. A coupling assembly as claimed in claim 1, wherein the port has an annular surface further inside the port than the position of the third diameter, the annular surface defining a portion of the port having a fourth diameter smaller than said third diameter.

15. A coupling assembly as claimed in claim 14, wherein the fourth diameter is substantially equal to an inner diameter of the end of said conduit that can be slidably inserted into the port.

16. A coupling assembly comprising:
 a component face defining a port opening for a port that extends in an axial direction into the component,
 a first interior surface defining a first portion of the port;
5 a second interior surface defining a second portion of the port;
 a third interior surface defining a third portion of the port,
 wherein the first interior surface extends between the port opening and the second interior surface at a first angle relative to the axial direction, and
 wherein the second interior surface extends between the first interior surface
10 and the third interior surface at a second angle relative to the axial direction, the second angle being larger than the first angle;
 a conduit having an annular bead, wherein an end of the conduit can be slidably inserted into the port such that the end of the conduit is adjacent to said third interior surface and at least a portion of the annular bead extends beyond the port opening; and
15 a seal extending around the conduit adjacent to said second interior surface.

17. A coupling assembly as claimed in claim 16, wherein the second angle is in a range from 28 to 32 degrees.

18. A coupling assembly as claimed in claim 17, wherein the first angle is in a range from 8.5 degrees to 15.5 degrees.

19. A coupling assembly as claimed in claim 18, wherein the first angle is in a range from 11.5 degrees to 12.5 degrees.

20. A coupling assembly as claimed in claim 16, wherein the third interior surface extends in a direction somewhat parallel to the axial direction.

21. A coupling assembly as claimed in claim 20, further comprising a fourth interior surface defining a fourth portion of the port, wherein the fourth interior surface extends between the first interior surface and the port opening in a direction somewhat parallel to the axial direction.

22. A coupling assembly as claimed in claim 21, wherein the first angle is in a range from 8.5 degrees to 15.5 degrees.

23. A coupling assembly as claimed in claim 22, wherein the first angle is in a range from 11.5 degrees to 12.5 degrees.

24. A coupling assembly as claimed in claim 16, further comprising a secondary port opening for a secondary port that extends in a second axial direction into the component,

a first secondary-port interior surface defining a first portion of the secondary port;

a second secondary-port interior surface defining a second portion of the secondary port; and

a third secondary-port interior surface defining a third portion of the secondary port,

10 wherein the first secondary-port interior surface extends between the secondary
port opening and the second secondary-port interior surface at said first angle relative
to the second axial direction, and

 wherein the second secondary-port interior surface extends between the first
secondary-port interior surface and the third secondary-port interior surface at said
15 second angle relative to the second axial direction.

25. A coupling assembly as claimed in claim 24, wherein said axial
direction and said second axial direction are somewhat parallel to each other.

26. A coupling assembly as claimed in claim 24, further comprising a fourth
secondary-port interior surface defining a fourth portion of the secondary port, wherein
the fourth secondary-port interior surface extends between the first secondary-port
interior surface and the secondary port opening in a direction somewhat parallel to the
5 second axial direction.

27. A coupling assembly as claimed in claim 16, further comprising a fourth
interior surface defining a fourth portion of the port, wherein the fourth interior surface
extends beyond the third interior surface relative to the port opening in a direction
somewhat parallel to the axial direction, the fourth interior surface defining a portion of
5 the port having a diameter that is smaller than a diameter of a portion of the port
defined by the third interior surface.

28. A coupling assembly as claimed in claim 27, wherein the diameter of the
portion of the port defined by the fourth interior surface is substantially equal to an
internal diameter of the end of said conduit that can be slidably inserted into the port.

29. A coupling assembly comprising:
a component having a first interior surface defining a portion of a first passage
that extends into the component in a first axial direction from a first aperture in an
external surface of the component, and having a second interior surface defining a
5 portion of a second passage that extends into the component in a second axial direction,

somewhat parallel to the first axial direction, from a second aperture in the external surface of the component,

wherein each of the first and second interior surfaces includes a counterbored surface, a first beveled surface, a second beveled surface, and a parallel surface
10 respectively positioned from the external surface of the component,

wherein the respective counterbored surface of each of the first and second interior surfaces is adjacent to the surface of the component,

wherein the respective first beveled surface of each of the first and second interior surfaces widens towards the external surface of the component at a respective
15 first angle relative to the respective one of the first and second axial directions,

wherein the respective second beveled surface of each of the first and second interior surfaces widens towards the external surface of the component at a respective second angle relative to the respective one of the first and second axial directions, and

wherein the respective parallel surface of each of the first and second interior
20 surfaces extends somewhat parallel to the respective one of the first and second axial directions,

a first conduit having a first conduit open end disposed within the first passage, and a first conduit external surface adjacent to the first conduit open end, the first conduit external surface being adjacent to the parallel surface of said first interior
25 surface, and having a first conduit annular bead adjacent to the counterbored surface of said first interior surface;

a second conduit having a second conduit open end disposed within the second passage, and a second conduit external surface adjacent to the second conduit open end, the second conduit external surface being adjacent to the parallel surface of said second
30 interior surface, and having a second conduit annular bead adjacent to the counterbored surface of said second interior surface;

a first seal extending around the first conduit and adjacent to the first beveled surface of said first interior surface; and

a second seal extending around the second conduit and adjacent to the first
35 beveled surface of said second interior surface.

30. A coupling assembly as claimed in claim 29, further comprising an anchor plate slidably fitted onto the first and second conduits such that the anchor plate at least assists in holding the first and second conduits fixed in positions relative to the component.

31. A coupling assembly as claimed in claim 29, wherein the first angle is in a range from 8.5 degrees to 15.5 degrees.

32. A coupling assembly as claimed in claim 31, wherein the first angle is in a range from 11.5 degrees to 12.5 degrees.

33. A coupling assembly as claimed in claim 29, wherein the component is a component of an automotive air-conditioning system.

34. A coupling assembly as claimed in claim 33, wherein the conduits are refrigerant lines.

35. A coupling assembly as claimed in claim 34, wherein the seals are o-ring seals.

36. A coupling assembly as claimed in claim 29, wherein the first interior surface includes a second counterbored surface, the second counterbored surface being adjacent to the parallel surface of the first interior surface on an end of the parallel surface further from the first aperture.

37. A coupling assembly as claimed in claim 36, wherein the first interior surface includes a second parallel surface extending from the second counterbored surface away from the first aperture, the second parallel surface of the first interior surface defining a portion of the first interior surface having an internal diameter substantially equal to an internal diameter of the first conduit open end.

38. A coupling assembly as claimed in claim 37, wherein the second interior surface includes a second counterbored surface, the second counterbored surface being adjacent to the parallel surface of the second interior surface on an end of the parallel surface further from the second aperture, wherein the second interior surface includes a second parallel surface extending from the second counterbored surface of the second interior surface away from the second aperture, the second parallel surface of the second interior surface defining a portion of the second interior surface having an interior diameter substantially equal to an internal diameter of the second conduit open end.